# LUBRICATION

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*Edited by*

L. H. CANFIELD, Ph. D.

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**Correspondence** is invited. Address all communications to Dr. Canfield.

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## EDITORIAL

The turbine oil recommendations of the Allis-Chalmers Manufacturing Company and the Westinghouse Electric and Manufacturing Company, published in this issue, indicate at once that these companies represent the most progressive element in the field of turbine manufacturers. It is especially gratifying to read in the Allis-Chalmers recommendations that, "All other tests, such as gravity, flash, fire and color, have no bearing whatever for this class of lubrication." This has been the stand of The Texas Company for years. The Allis-Chalmers recommendations have just hit the mark in specifying an oil that will do the work under service conditions. The essentials of a turbine oil are, as stated in their letter, ability to separate readily from water without forming emulsions or throwing down a deposit, freedom from acid and from all fixed oils, proper refining, and a viscosity suitable for the conditions under which it has to operate.

Texaco Cetus Oil, one of the oils recommended, has an enviable record as a turbine oil. The greatest single consumer of this oil is probably the United States Navy, which purchased during the fiscal year ending June 30, 1916, approximately 250,000 gallons. This oil was used chiefly for turbines, where the conditions are most exacting, and where the factor of safety is given the greatest consideration. When a higher viscosity oil is desired Texaco Alcaid Oil may be used. Texaco Algol Oil and Texaco Ursa Oil are intended for use where a very heavy bodied oil is desired, the latter only for the heaviest types of marine turbines.

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The article in this issue on Ice Machine Lubrication is practically a reprint of an article which appeared in the June issue of National Petroleum News. While The Texas Company advertises a cold test of five degrees below zero for its ice machine oils, they have as a matter of fact a much lower cold test. By the ordinary methods of testing it is impossible to get a

temperature much below zero, but we recently made a test on one of our ice machine oils by means of solid carbon dioxide and acetone, in which test the oil would still flow at a temperature many degrees below zero. Texaco ice machine oils have a cold test as low as, if not lower than, the Russian oils which were sometimes used before the introduction of ice machine oils from asphaltic base crudes. All Texaco ice machine oils are pure, acidless mineral oils; in fact they meet all requirements mentioned in the article referred to.

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It is strange how erroneous ideas and beliefs persist, even after they have been thoroughly discredited. This is particularly true in the field of lubrication where high flash and high Baumé gravity have been preached by the manufacturers of northern crudes until they partake of the nature of a fetish. Every now and then an article advocating such tests is published, either to bolster up the old beliefs, or else because the writer is still uninformed as to the developments in lubrication during the past ten years.

A good example of such an article appeared recently in one of the most widely distributed technical magazines.* The writer of this article proposes the following amusing method of determining the rating or percentage of quality of a lubricating oil:

**Rule for Rating Oils**

| | | | |
|---|---|---|---|
| A | Viscosity at 120 degrees F. | × | 1 |
| | Viscosity at 180 degrees F. | × | 10 |
| | Flashpoint | × | 1 |
| | Multiply and add the products. | | |
| B | Congealing point | × | 1 |
| | Free acid | × | 100 |
| | Carbon content | × | 100 |
| | Multiply and add the products. | | |

Subtract B from A, divide by 5 and then multiply by the specific gravity. The result is the percentage of quality. If the viscosity at 70 degrees F. is considered, divide 100 by this figure and add to the quantities in A.

If this formula were to be treated seriously the fallacies would be apparent at a glance. In the first place, viscosity is not a matter of quality but is important simply because it indicates the suitability of an oil for the particular work involved. A high viscosity oil which would receive a high rating according to this scheme might be eminently suitable for certain heavy slow moving bearings, but would at the same time be totally unsuitable for light swiftly moving bearings.

It should also be remembered that the flash point, which receives by far the greatest amount of consideration in determining the percentage of the oil by this method, has, after all, very little bearing on lubricating value, providing it is sufficiently above the bearing temperature to prevent excessive evaporation of the oil and to allow a reasonable margin for safety.

We refer to this article simply for the purpose of emphasizing the fact that lubricants should be selected on a basis of choosing the right oil for the right place. Quality can best be determined by an actual test on the machine to be lubricated. The oil that lubricates best, with the least frictional heat, and with the least consumption of oil, is the best oil, irrespective of gravity, flash point, or other laboratory tests, or of any percentage that may be arrived at by conjuring with these various tests.

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* *Power*, Vol. 43, No. 24, June 13, 1916, p. 848.

# LUBRICATION OF STEAM TURBINES WITH RECOMMENDATIONS OF TURBINE MANUFACTURERS

By W. F. Parish

The constantly increasing use of steam turbines as prime movers, particularly in connection with the generation of electricity, has resulted in a great amount of attention being devoted to the subject of turbine lubrication. A few years ago almost any available oil was used in a turbine, but as a result of the remarkable developments in turbine construction and the consequent study of turbine lubrication, both by the manufacturers of lubricants and the manufacturers of turbines, special oils are now produced which are particularly adapted to this use.

The demands made upon an oil in a turbine are exceedingly severe. The oil must circulate at high speed through innumerable valves, pipes, and bearings, subjected first to high and then to low temperatures, and to many variations in pressure. It is thoroughly mixed with air, so much so that foam is quite frequently found on top of the oil in the settling or sump tank. Air bubbles can always be seen as the oil flows from the bearings. Frequently it must operate with a percentage of water which leaks through from the stuffing boxes, or with water that leaks in from an imperfect or damaged cooler coil, or, in the case of marine installations, salt water can sometimes get into the system from overboard. At times the oil in the bearing in close proximity to the stuffing box is actually cooked by the live steam. The steam carries with it boiler impurities or chemicals used for boiler water treatment and very often these chemicals in connection with the water and air cause the oil to form very bad emulsions. Any oil that has a tendency to form an emulsion is rather dangerous for use where the churning, heating, and boiling with water and boiler compounds are carried on to such an extent as in a turbine lubricating system.

Much damage has been done to turbines because of the tendency of certain oils to emulsify. Some oils will throw down a hard emulsion which, under the conditions which prevail in the turbine, will cake in such a way as to actually stop up the pipes and oil-ways in the bearings. Other oils carry the water in suspension and are of such a nature that the water will drain off only with great difficulty. The best turbine oils, of course, are those that under all conditions will allow whatever water gets into them to drain off and will produce a minimum amount of emulsion, this emulsion being of such a nature that it will not form a hard deposit. The perfect oil is one of high lubricating body which will separate freely from any amount or any kind of water after it has been thoroughly agitated and even boiled and which will leave absolutely no permanent emulsion.

Next in importance is the question of viscosity. At one time the American oil manufacturers used the very lightest distillates for turbine work, the theory being

that these lighter oils separated easily from water and formed less objectionable emulsions. The factor of safety, however, was exceedingly small with these light oils. The many mechanical difficulties experienced while these low viscosity oils were in use resulted in the demand for heavier oils, until in some turbines doing very severe work, very heavy oils are now being used with complete success. The majority of turbines, however, can best be lubricated by a medium bodied oil such as TEXACO CETUS OIL.

It will be of general interest to read what the leading turbine manufacturers have to say in regard to the lubricating oil to be used in their turbines. It will be remembered that not very long ago these manufacturers specifically advocated the use of oils made only from the limited crude production of the Pennsylvania fields, due to the fact that for many years this particular class of lubricants was the only one offered for all kinds of work, and that the specifications which described these lubricants prevailed even after the introduction of other oils meeting entirely different specifications. At the advent of the asphaltic base lubricants, due to the newness of these oils and the apparent difficulty in properly refining them, they were not at first considered as adaptable for this severe class of work. Later, however, as improvements were made in the oils themselves, and very largely on account of the remarkable work of the TEXACO turbine oils in the United States Navy on turbines of all kinds and descriptions working under every conceivable condition, the specifications have been broadened or eliminated, and the manufacturers have attempted to specify that a class of oils should be used which on the basis of features such as emulsification tests, are particularly suitable for this class of prime mover. These requirements cannot exactly be termed "specifications," but are rather an attempt to give information as to the actual physical conditions that must be met by the oil in the lubricating system attached to the turbine. TEXACO CETUS OIL meets every requirement and specification for an excellent turbine oil and is, in fact, the oil upon which many users and builders of turbines base their specifications.

The ideas of the Westinghouse Electric & Manufacturing Company in regard to the subject of turbine lubrication are embodied in the following circular letter sent out to their erecting engineers:

To All Erecting Engineers,
The Westinghouse Machine Company.

**LUBRICATION**

In the past, this Company has made a practice of advising users of our turbines of certain brands of oil which have been found satisfactory. For good and sufficient reasons, from this date the practice will be discontinued. On inquiry from a purchaser, as to the best brand of oil for him to use, we will advise him of the following general requirements of Turbine Oils:

So far as mere lubrication of the turbine is concerned, almost any oil at all has lubricating properties sufficient for the bearings to run cool, so that the fact of the bearings running cool and nice is no criterion of the suitability of the oil.

A large quantity of oil is in circulation in the turbine at a temperature of from 100° to 120°, or thereabouts, which temperature is conducive to any chemical reaction, should the necessary elements be present. It is therefore important that the oil be an absolutely pure mineral oil, free from acid. Sometimes mineral oils are adulterated with animal fats, which will in the course of time decompose, forming acids, corroding the shaft, and even eating up the bearing metals.

Some oils have sulphuric acid employed in the process of refining, which is subsequently washed out. These would appear to be dangerous oils to use, as sometimes the washing might not be complete.

Other oils contain paraffine, which in the operation of the turbine is found to become separated from the oil, choking up the oil passages, and depositing on the cooling coils, interfering with the heat transmission.

One of the most prolific causes of trouble with turbine oils is their emulsification into a more or less solid, jelly-like substance, should water become mixed with certain oils, as is, of course likely to happen. It has been found that high viscosity oils are more prone to this difficulty than oils of low viscosity. It is therefore important that the oil used be capable of readily breaking from water, and have the physical characteristic of not emulsifying when violently agitated.

For turbines running in connection with reduction gears, oils of higher viscosity than regularly employed for turbines, are required, so as to provide a more indestructible oil film between the tooth surfaces.

The effect of the higher viscosity oil on turbine bearings will only be that their range of working temperatures will be a few degrees higher. The question of emulsification is therefore of more importance with geared outfits than with regular turbine installations.

We are frequently sent samples of oil, with the request that analyses be made. In this connection would state that chemical analysis is no criterion whatever as to the suitability of any oil for turbine lubrication. The only test on which any reliance can be placed is to give the oil a thorough trial in service in the turbine. We therefore must decline to make chemical analyses of oil.

If the turbine oiling system is once charged with oil, the oil consumption is practically nothing, and only that due to leakage or spilling, so therefore, the price paid for oil should be regarded as of minor importance, compared to the quality.

Yours very truly,
(Signed) H. M. GILES,
Gen'l Supt. of Erection.

The following is a copy of a letter sent out March 30, 1916, by the Allis-Chalmers Mfg. Co. of Milwaukee, Wisconsin, to all of their erecting engineers and salesmen:

## LUBRICATION OF STEAM TURBINES

All previous letters issued by this Company in regard to the kind of oil to be used for the lubrication of steam turbines are hereby superseded.

In order that there may be no misunderstanding as to the position taken by our Company in the matter of the so-called recommendation of various brands of lubricating oils to be used in connection with our steam turbines, we must advise that we do not recommend any oil in the sense that we guarantee its continued quality or suitability, or that we assume any responsibility for the results obtained from its use. Our only representation to customers is that certain brands of oils have on the average been found satisfactory for the lubrication of our steam turbines and that as long as the quality is maintained at the same standard, we have confidence in them and endorse their use.

All of our men, however, should be careful not to attempt to dissuade any customer from buying any suitable oil he may desire on the ground that we will not be responsible for any trouble arising from its failure, as this is equivalent to stating that we would be responsible in case of failure of any of the oils named in this letter, and which our past experience leads us to believe are good.

Our steam turbines are designed with bearings of liberal proportions, and will operate satisfactorily with any good high grade oil suitable for this class of service, and the only interest which we have in the matter of lubricating oils is that of obtaining satisfactory operation of our turbines.

We have found it generally true in steam turbine lubrication that, while one oil may be suitable in the majority of cases, there are, from time to time, turbines that seem to require either a heavier or a lighter oil and this makes it inadvisable to issue a fixed specification governing this one class of work.

A suitable oil for the lubrication of steam turbines must have certain general characteristics which, in the order of their importance, are as follows:

The oil must be so made and of such a nature that it will separate freely from water, and that water of any nature or any temperature being agitated with the oil in any amount will not form an emulsion; even if the conditions require the oil and water to work together so that a mechanical mixture of the oil and water is secured, the combination must

not be permanent, but upon resting and being subjected to a heating temperature of not over 175° F., the water must separate. Preference should always be given to the oil separating the most quickly after being agitated with water that will be used for boiler purposes at the plant where the turbine is located. Tests should be made by shaking 50% of oil and 50% of water in a bottle or by mechanically stirring this mixture in a suitable container for, say, ten minutes, and noting the separation of water after ten minutes and after twenty-four hours.

Any oil that in the above tests, or in practice, will throw down a deposit, should under no conditions be used for turbine lubrication, as this deposit may under severe conditions interfere with the flow of oil to the bearings.

Oil in order to meet the above conditions, must be free from acid, free from all fixed oils such as vegetable and animal oil, and should be properly refined.

The leading manufacturers of lubricating oil have introduced the practice of determining a property known as "viscosity." To determine the body or viscosity of an oil, a standardized viscosimeter is used, by means of which the time occupied in the flow of a measured quantity of oil through a small orifice at a given temperature is measured. The Saybolt Universal Viscosimeter is commonly used for this purpose by the large producers and refiners of lubricating oil in this country, the sample of oil being maintained at a temperature of 100° F., and the time occupied in the flow of this measured sample of oil through a small orifice being measured in seconds. This time reading represents the relative viscosity of the oil which, in the majority of cases for steam turbine lubrication, should be about 200 seconds at 100° F. Saybolt Universal.

Should it be desired to operate the turbine with a very slight reduction in temperature of the bearings, oil as light as 150 seconds viscosity for the majority of turbines can be used. On the other hand, should the mechanical conditions require oil of heavier body, an oil as heavy as 750 seconds at 100° F., Saybolt machine, can be used. All of these oils, however, irrespective of the body or viscosity, should conform absolutely to the separation from moisture or water tests. All other tests, such as gravity, flash, fire and color, have no bearing whatever for this class of lubrication, but it might be well to be more explicit in regard to these particular tests.

### Gravity

The gravity of an oil is the ratio of its weight to the weight of a like quantity of distilled water at 60° F. temperature. This feature of an oil has absolutely no bearing in regard to its lubricating properties. In the oil business, the gravity reading has some value as it denotes that the oil comes from the various crude oil fields; for instance, a high gravity oil, that is, one that has a gravity Baumé of 30°, can only be made from a paraffine base crude; paraffine base crudes are found in Louisiana, Texas, Pennsylvania, Indiana, Ohio and the West. Low gravities of, say, 20° Baumé, indicate that the oil is made from an asphaltic base crude, produced in the Southwest or from the California or Russian crudes which have a somewhat similar nature. An attempt to dictate the gravity that the oil should have is simply an effort to secure oil from a certain field or a certain refiner.

### The Flash Point

The flash point of an oil is the temperature at which the oil, when heated, will give off a vapor which in combining with the air will ignite upon introduction of a flame. Any oil as low as 150 seconds viscosity that could possibly be used on a turbine would have a flash point of over 300° F., which is a temperature way beyond any point that would be reached in an oil circulating system attached to a turbine.

### The Fire Point

The fire point of an oil is the temperature at which the oil will support a flame on its surface. This is generally 40 to 60 degrees above the flash point. This also has no bearing whatever on the question of a suitable oil for turbine lubrication.

### The Color

The color of the oil is unimportant, as some refiners with certain crudes have certain processes of refining and run their stocks to red oils; others run the same crudes to light oils. Further, filtering and different refining processes can make a light colored oil out of a dark one. If the oil will meet the general emulsion specification and the viscosity tests, the color, even should it change with age in the system, is of no importance whatever.

### Temperature of Bearings

The temperature of a bearing in a turbine working on a forced feed system is in proportion to the viscosity or body of the oil; that is, if a very heavy bodied oil is used, the partially resulting bearing temperature can be reduced to certain limits by the use of a lighter bodied oil. There is a limit to the lightness of the oil, which, in the majority of cases, should not be less than 150 seconds viscosity on the Saybolt Universal machine. The temperature of a turbine bearing, however, is not a point of the greatest value in turbine lubrication. The oil heavy in viscosity has the very valuable feature of staying on the surface of the bearing after the turbine has come to rest, so that in starting, the surfaces are well lubricated. Further, heavy bodied oils will take up bigger clearances and operate with rougher bearings and shafts without danger, whereas, under these abnormal conditions, light bodied oils would invariably lead to trouble, as the oil would not have sufficient thickness of film to keep the high points of the surfaces apart.

The actual mechanical frictional difference, or the effect upon the mechanical efficiency of the turbine, between the use of a heavy and a light oil on a turbine having two or three bearings is infinitesimal.

Water is the main deteriorating element to the life of a turbine oil, therefore, special attention should be given to keep water out of the circulating systems and out of all filters. The system should be a dry one, and daily inspection should be made to see that water is not getting in. The oil that will meet the water test can be used indefinitely in a turbine by being added to from time to time.

The following list of oils, which have been used in our steam turbines and found satisfactory, is to be submitted by you, without recommendation, to any of our customers who request information regarding the kind of oil to be used in our steam turbines; the selection of the particular brand to be left to them. . . . . .

(Signed) L. E. Strothman, Manager,
Steam Turbine Department.

The Allis-Chalmers Company lists six turbine oils, of which TEXACO CETUS OIL is one.

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## ICE MACHINE LUBRICATION

An interesting article on Ice Machine Lubrication appeared in the June issue of the National Petroleum News.* According to a refrigeration engineer, whose opinion is quoted at length in the article—"The first requisite of a good ice machine oil is that it be a pure, acidless mineral oil. Any animal or vegetable oil tends to congeal in the system, presenting the danger of choking it up. Any acid that might be present in the oil not only would affect the walls of the compression cylinder, but also might have a bad effect on the ammonia gas.

"The next requisite in point of importance is the cold test. This should be down to zero, although the cold test in the majority of oils used is seldom below four or five degrees above, and this seems to be sufficient in most cases. A practical cold test which every refrigeration engineer uses is to immerse a bottle of a few ounces of oil in the brine solution. If at the end of 48 hours it flows as readily as before it was placed therein it is cold resisting enough for ice machine work.

"The flash and fire tests are not so important, as the temperature in the compressor probably never reaches over 250 degrees except in a few machines of a peculiar type. There have been instances of explosions in the compressor, where it was thought the temperature might have been high enough to

* "Poor Oil Plays Havoc with Ice Machines" in *National Petroleum News*, Vol. VIII, No. 4, June 1916, pp. 50-53—reprinted by permission.

ignite the oil. This is almost certainly a fallacy, however. A viscosity test is also of little importance in testing ammonia oil, for there is almost no frictional heat developed. . . . .

"There is a certain amount of oil lost through leaks at the 'stuffing box,' and by working into the system. It is also believed by some that some of the oil carbonizes at the temperature reached in the compressor, as deposits of a dark brown substance are found there which look something like carbon in the cylinder of a motor car. There is a great question, however, as to whether the temperature reached is high enough to develop carbonization under any circumstances.

## Used Traps and Filters

"The oil which works into the system can be removed at the oil traps, filtered and used again, thus making the amount of oil used in operation of the average machine very low, indeed. Some engineers avoid filtering their used oil through water, as is common in most filters, because of the danger of the water not being entirely removed, and thus being introduced into the refrigeration system when the oil is used over again, where it works bad results. Others do not regard this as bad practice, however. The consumption of oil for a 500-ton machine would probably not be more than a barrel a year.

"If a heavy consumption of oil is demanded by any particular machine it is almost certainly an indication the oil is working into the system, rather than performing its function in the 'stuffing box.' This may be due to bad packing, or it may be due to the wrong kind of oil being used."

The article further says:

"At least one refrigeration engineer— . . . whose plant is said to be the largest in the world—is of the opinion there is no great harm sustained even though a considerable amount of oil finds its way into the refrigeration system, provided that the proper kind of oil is being used, for they claim it is very easy to remove the oil at the traps before it reaches the expansion coils where it would have the effect of an insulating agent. Purifiers are now being developed to separate more quickly and efficiently the used oil and ammonia. This company for a time used a Russian oil exclusively in their ice machines because it had a lower cold test than any American oil on the market."

"The operation of the compression system, briefly, is this: The refrigerating agent in gaseous form is subjected to pressures sufficient to reduce it to liquid form. At this stage heat is developed. This heat is removed by forcing the condensed refrigerating agent still under pressure through water-cooled pipes. It is then admitted to a vacuum in a series of expansion coils, and, being relieved of pressure, instantly expands into gaseous form. In this particular stage of the process it gains the heat which was lost during condensation, taking it from the surrounding atmosphere and cooling a limited area to the point necessary for refrigeration. The operation, of course, is continuous.

## Oil Serves Two Ends

"The portion of the apparatus which calls for the peculiar need for lubrication which has led to the development of ice machine oil is the compressor, where the ammonia gas returns from the expansion coils, having fulfilled its purpose

by taking a certain amount of heat from the atmosphere in the refrigerating room, and is ready to be condensed and returned again through the system. This oil fills two purposes. It lubricates the piston of the cylinder, which compresses the gas, and, being much heavier than the ammonia gas, it has a tendency to hold the gas in the compression chamber back, thus sealing the space between the piston rod and the 'stuffing box,' as it is called, preventing the ammonia gas from escaping into the atmosphere in the engine room. In some types of machines the lubricating oil is introduced at the end of the suction stroke of the piston to take away the heat of compression, the oil being cooled before being used again."

"In connection with the marketing of an ice machine oil there is considerable need for the education of engineers operating this type of machinery, which education must come in large part from the salesman handling such grades of oil. In only very few instances have engineers at ice and refrigeration plants been at all familiar with the peculiar need for lubrication their plants presented, a recent canvass made by THE NEWS has shown . . . . In some cases the engineers have not even appreciated that to get any degree of efficiency out of their apparatus they must use an oil especially made for this purpose, and they have used ordinary engine oil. Still others, appreciating they knew little about the subject, have been content to use one brand of oil if it gave a fair degree of satisfaction, and have been afraid to make a change for fear the oil would not prove so satisfactory."

"The use of refrigerating apparatus, and consequently the need for a good lubricant for such apparatus is increasing at a very great rate, however. As an example, one company manufacturing this kind of machinery put in 160 installations last year, and other companies have done nearly as well. Not only are they being used in the process of artificially manufacturing ice and in cold storage plants, but they are coming more and more to be used in hotels, hospitals, theaters and public buildings for cooling the air in connection with ventilating systems, and they are even being installed in the private residences of the well-to-do."

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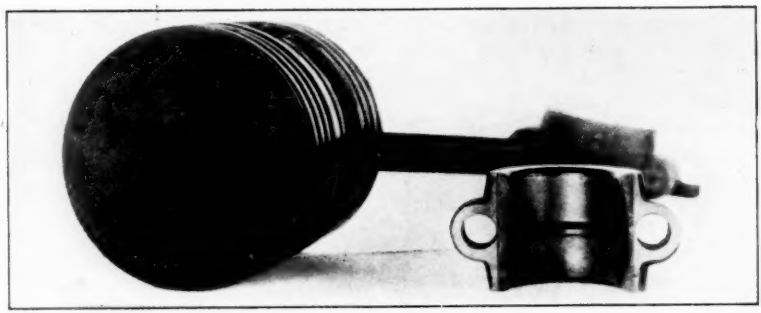
## MOTOR OIL EFFICIENCY

We receive numberless letters relating to the excellent results obtained by the use of TEXACO MOTOR OIL, particularly when used along with TEXACO GASOLINE. The letter printed below was sent by the General Lubricating Assistant in the Houston office to a number of District Superintendents. This letter was intended only for the personal use of these superintendents, but it pays such an eloquent tribute to TEXACO MOTOR OIL that we are taking the liberty of publishing it in full, together with the photographs referred to.



**Piston and Bearing**

Houston, May 17, 1916.

Subject: Texaco Motor Oil,
Gasoline and Thuban
Compound in Winton Cars

Gentlemen:

By today's mail under personal cover I am sending you a pair of photographs which have been made within the last few days of a piston complete with rings, crank brasses, intake and exhaust valves and a spark plug, all taken from a cylinder of a six-cylinder Winton automobile used by this Company at Houston for the last two years.

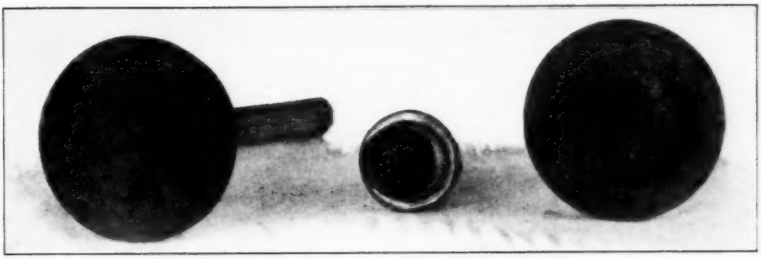
This Winton car has been in constant use, and I am informed the distance traveled by it in that time includes approximately 25,000 miles.

I am reliably and positively informed that during this period of use, the car has never been taken apart for repairs, there has never been a valve ground or bushing removed, and most remarkable of all, there has never been a spark plug taken out for renewal or cleaning. Spark plugs, valves, bearings and other working parts have never been touched, nor has the motor ever been opened to inspect working and moving parts since the car was bought until last week, when the mechanism was taken apart for cleaning preparatory to painting the car.

During the entire period of use the car has been operated on Texaco Gasoline and lubricated with Texaco Motor Oil M and the gears with Thuban Compound properly applied. The car has again been re-assembled without any repairs other than cleaning of the working parts and is now in the paint shop. It was not necessary to grind a valve, as compression is perfect. Please take a reading or other magnifying glass and examine carefully the tops of the valves shown in the photograph. The intake valve on the left shows a small amount of carbon, which is soft to the finger. The exhaust valve on the right shows the merest darkening with the products of combustion, and this is plainly proven by the indentification mark and figure "4" marked on this valve. This figure "4" shows clearly there has been no carbon deposit. Equally as remarkable is the condition of the spark plug, which only showed a slight smut, such as might be made by holding the plug over the flame of a kerosene lamp for a fraction of a minute.

The face of the piston clearly shows what a small quantity of products of combustion has been deposited on it. Much of the surface shown in the photo is clear metal similar to the surface of the intake valve in the other picture, and at no point is the carbon thicker than possibly a thirty-second of an inch. This carbon is soft and can be readily crushed between the fingers. It is soluble in Gasoline or Kerosene. The packing rings are perfectly clean and loose, and there is positively not the slightest trace of gum anywhere to be found.

The face of the brass speaks for itself and will stand the closest scrutiny under a glass. The bearing has, of course, been worn chiefly on the side uppermost on the photo, but close inspection will show you that the wear has not been great and chamfer marks can be seen on the edge, and you can readily find the tool marks which were made when the brass was manufactured and fitted. The wear on this bearing surface has been so exceedingly slight that I do not know how in practice it could be measured, unless by the same instrument in use at the factory when the machine was put up and by the same man who possibly calipered the cylinder, etc., as the personal equation in taking such measurements would make the result uncertain.



**Valves and Spark Plug**

These photographs are worthy of a frame as an actual demonstration of results obtained by the use of our Gasoline and lubricants under the severest working conditions over a long period of time, and you may regard the above record as absolutely authentic and positively correct in every particular. I regret there was no opportunity to measure what wear there might have been on the walls of the cylinders, but can only say that the pistons and rings were put back just as they were taken out without renewal or any work on them, and the compression remains perfect. The Winton expert who examined the car after it was taken down stated that the wear on any of the moving parts was positively negligible according to the best standards in use at this time, and agreed with me that it would be difficult to accurately determine what trifling wear there had been, and I can not conceive of a stronger demonstration of the superior quality of our products or a better opportunity for advertisement of same with car owners and dealers who regard quality and the life of the machine they are interested in selling.

Yours very truly,

(Signed) R. C. GALBRAITH,
General Lubricating Assistant.

## SALESMEN'S STORIES

"I am pleased to add the largest automobile company in my territory to my list of barrel consumers of Thuban Compound.

"They told me a new Thuban story.

"One of their customers brought in an '8' and wanted to sell it. Could not stand the knock in the differential. While he was telling this to the Sales Manager, the service man gave it a shot of Thuban. When the owner came out neither he nor any of the others present could find the knock."

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"On May 24th this customer applied our TEXACO Graphite Axle Grease on one side of several of their wagons against their regular grease on the other. Upon examination on June 1st, they reported that there was really no need for greasing the side that had been greased with TEXACO. They have some one hundred and twenty-five wagons and two hundred to two hundred and twenty-five horses, some of their hitches being up to ten horses, two of the wagons on which our grease was tried being eight-horse hitches. I called on the buyer for this concern, who, after receiving a report of the successful result of this tryout of our grease, informed me that he would place his future orders for this material through me, and would ask us to quote on their cylinder oil for the coming year, the contract for which expired on July 1st. While axle grease is but a small item I feel somewhat elated to think that we are to have their business, and as they are second only to Barnum and Bailey in size and type of their equipment I expect to 'clean up' on axle grease around here on the strength of their results."

# A DAY WITH THE ENGINEERS

The technical reports from our various experts in regard to their daily work make interesting reading, particularly at the present time, when the development of TEXACO CRATER COMPOUND is constantly throwing light upon lubricating difficulties encountered in practically every type of plant. Ordinarily such difficulties are rarely mentioned by the plant operators. They have undoubtedly existed for such a long time in practically every class of business that they have been accepted as a matter of course and no special mention is ever made of them. Our experts, however, are making a special effort to unearth these troublesome points in order to show that Crater Compound will do away with difficulties that have always been considered insuperable.

The following reports cover a few interesting cases:

**Illinois**—The most difficult point for lubrication on a Parsons dredging machine was a motor drive which was located along the side of the fire box of a vertical boiler and was consequently subjected to considerable heat. The gear carried a pan containing black oil, which they had been using as a lubricant. The gear and worm were of cast steel and were badly worn, the worm being cut away. In cleaning out the pan prior to the introduction of Crater Compound a large amount of metal was found. After this gear pan was filled with Crater Compound, the gears ran smoothly and quietly, and everybody was pleased with the results.

**Pennsylvania**—The manager of the plant turned me over to the master mechanic who showed me the most severe conditions about the plant on which to demonstrate Crater Compound. No. 1 and No. 2 winding machines were selected, the master mechanic stating that owing to the enormous pressure exerted on the gears, they had never been able to get a gear coating that would stand the service. The winding machines are manufactured in their own shops. The gears were cleaned and Crater Compound, properly heated, was applied, and very good results were obtained almost immediately. Crater Compound adhered perfectly to the gears, overcoming the clattering sound which had heretofore been experienced. The master mechanic was greatly surprised at the results and was pleased to have at last found a lubricant that would meet these severe conditions.

**Indiana**—The most severe condition in this plant was the gear of the revolving drying barrels. It had formerly been impossible to lubricate these gears properly due to the continuous running and the weights on the overhung barrels. Immediately after the application of Crater Compound it was noticed that the noise had been considerably reduced.

**Massachusetts**—In the plant they are running a comparative test between Crater Compound and grease in a hydraulic press. As they are using Crater Compound on the gear and pinion on one side of the machine and grease on the opposite side, this makes an ideal place to compare the action of these two different products. It was found that the noise produced by the gear on which grease is used is so great that no noise can be heard from the gear on which Crater Compound is used, if there is any noise produced. When the superintendent's attention was called to this fact, it pleased him greatly.

**Pennsylvania**—The hydraulic pumps in this plant are driven by steel herringbone gears, pinion gear 8″ in diameter by 8″ across the face, driving gear 80″ by 8″ across the face. These gears have sharp ragged edges on the teeth at the present time and are a very difficult set to lubricate on account of the high speeds and heavy work performed. Various well known greases have been used on these gears but with very little success as indicated by the wear and the condition of the surrounding walls, which are covered with grease to a height of six feet, this grease having been thrown from the gears. I cleaned these gears and made a very successful application of Crater Compound. The floor had recently been painted and after three days' operation there were no signs of dripping or throwing whatever.